Plant More Trees!

by Kate Lessing

The short answer is to plant more trees. The question is how to use damaged and unproductive land to reduce net greenhouse gas emissions.

The problem is that just planting trees will not ensure optimum carbon accumulation. Most Appalachian reclaimed mine land, for example, is heavily compacted, finely textured with a high coarse fragment content, poorly aerated, and poorly drained.

The eastern hardwood forest is one of the most diverse and productive temperate hardwood forests in the world. Photo by Jim Burger, Virginia Polytechnic Institute and State University

These infertile soil conditions are unsatisfactory for native forest establishment, growth, and long-term productivity. How to maximize productivity on such soils is the subject of two NETL terrestrial sequestration projects.

This graphic photo from Virginia Polytechnic Institute and State University shows the forest and soil removed during a surface mining operation.

NETL awarded terrestrial sequestration projects to the University of Kentucky and corporate partner Peabody Energy (project cofinanced by the U.S. Forest Service); and Virginia Polytechnic Institute and State University and corporate partners Mead-Westvaco Corporation, Plum Creek Timber Company, and Mountain Forest Products Company.

Terrestrial ecosystems are major biological "scrubbers" for carbon dioxide, and reclaimed mine lands provide an excellent opportunity to sequester carbon in both soils and vegetation, because reclaimed areas are essentially devoid of soil carbon. The land is usually reclaimed to grasses and other herbaceous vegetation─which have a lower carbon-accumulation potential than trees. Forests provide other ecosystem benefits over grasslands, including flood protection, wildlife habitat, and protection for endangered species.

Some of what the scientists already know and have proved is almost common sense: (1) the denser the tree, the more carbon it can hold; and (2) the rate of carbon accumulation is fastest during optimum growth or when the tree has not reached maturity. What they don't know is how different types of mine spoil affect survival and growth rates of different tree species, and how much spoil preparation and forest management (and thus money) are needed to optimize tree survival and growth and carbon accumulation.

Researchers will map mine soil properties in one project; and will plant a mixture of native tree species on different types of mining spoil at active reclamation sites in the other project. The purpose of both projects is to find out and measure what conditions yield the highest rate of carbon sequestration in the shortest amount of time and at the lowest cost. The goals are to maximize forest carbon sequestration on reclaimed mine lands at the lowest possible cost, and to measure the carbon sequestration and wood production benefits.

University of Kentucky Project

The Kentucky scientists believe that their study could help change current mine reclamation perceptions and practices to make loose dumped material and forest establishment the preferred choice. The Surface Mine Reclamation Act, established in 1977, requires that mined lands be returned to their approximate original contours, which means extensive spoil compaction if the land is reclaimed to grassland. And researchers have found that most species of trees survive better and grow faster on uncompacted spoil. The Kentucky researchers hope to conclusively demonstrate this.

A hardwood seedling has been planted in uncompacted spoil. University of Kentucky researchers plant tree seedlings on an eight-foot by eight-foot spacing to achieve a planting density of 680 trees per acre.

Three studies will be conducted on a total of about 500 acres in three distinct mining regions in southeastern and western Kentucky:

1. Comparing tree species, including monotypic and mixed species with and without a nitrogen-fixing species;

2. Comparing different depths of the spoil material; and

3. Comparing various spoil types.

Each of the three demonstration areas will be on fresh spoil that is loosely dumped.

These northern red oak (foreground) and white ash (near background) saplings, planted by University of Kentucky researchers, are in their third growing season.

Virginia Polytechnic Institute and State University Project

This 16-year-old forest on mined land in Virginia was established by converting grass-covered compacted mine spoil, and the productivity of this forest stand is equivalent to or better than adjacent undisturbed sites. Native hardwoods have begun invading the forest stand.

The Virginia scientists plan to analyze how mine spoil properties influence the amount of carbon sequestered by comparing mined and non-mined forest lands. The researchers will analyze the carbon sequestration rate and amount for 14 mined and 7 non-mined forest sites and develop mine-soil classification criteria.

The mine-soil classification part of the project will take place on three 30 to 40 hectare sites that have been reclaimed to grassland in Virginia (owned by Mountain Forest Products Company), West Virginia (owned by Plum Creek Timber Company), and Ohio (owned by Mead-Westvaco Company). Researchers will develop geographic information system (GIS)-based maps of each site to delineate forest site-quality classes, and the three sites will be used to develop and test their forest site-classification system.

Three forest types (mixed native hardwoods, alkaline-tolerant hardwoods, and pine) will be planted at each location using three levels of forest management. The treatments will range from "plant and walk away" to state-of-the-art management designed to optimize growing conditions for the trees. Tree survival and tree height and diameter will be measured, and the data will be used to model biomass accumulation of each stand and the total ecosystem carbon accumulation. Finally, the Virginia researchers will perform a cost-benefit analysis.

Nitrogen-Fixing Trees

Plants need nitrogen to grow. Legumes (including some trees) are nitrogen-fixing plants—they accumulate nitrogen from the air and deposit it in the form of nitrates in nodules on their roots.

Research has suggested that the nodules on nitrogen-fixing trees (NFTs) transfer nitrogen directly to the roots of non-nitrogen fixing trees. The roots of NFTs contain more nodules when they are in close contact with the roots of non-nitrogen fixing trees. Researchers have also found that carbon sequestration is significantly boosted when tree stands include NFTs, probably because nitrogen added to the soil inhibits decomposition of carbon in the soil.

Mature Black or Common Locust Tree

Black Locust Leaves

NFTs are often deep rooted, and they can quickly "pioneer" bare or degraded lands. NFTs establish readily, grow rapidly, tolerate poor soils and drought, thrive in full sun, enhance overall fertility, and regrow easily after pruning. NFTs are so prolific that they are often considered weeds. NFTs in the United States include black locust, honey locust, and alder.

Black locust photos from "What Tree Is It?," Ohio Public Library Information Network (OPLIN) and the Ohio Historical Society (OHS)
http://www.oplin.lib.oh.us/products/tree/